



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

man may succeed in the United States if he does begin his professional work as late as twenty-five years of age.

C. H. Thurber

THE EDUCATION OF A NATURALIST*

In the early days of science, when there was a good deal of unclaimed and uncultivated ground lying about, men sometimes dropped into science by the merest chance, some of them with but little preparaeion for the work, and many of them with less. Nowadays we have changed all that. And yet, as might be expected, there are still plenty of persons of intelligence who have no conception whatever of the duties of a scientific man ; those who imagine that science as a profession can be picked up just as the duties of certain civil offices, or of clerical positions, may be readily learned and performed by any man of ordinary intelligence. Among the applications I have received for employment upon geological surveys under my direction, one man gave as a reason why he should be employed that he was a graduate of West Point ; another was interested in geology and had read many books upon the subject, among which he cited some of the vaporings of Ignatius Donnelly ; another used to be acquainted with Professor Winchell ; and another was in poor health and thought field-work would be good for him ; and still another was a consistent member of the Presbyterian church. At least half of the applicants have asked for employment because they understood ordinary land surveying ; and one of them admitted that he had no other qualification than that he was " a good hand to camp out."

But this dropping into science of such men is no longer possible, and we now realize that those who are to do the scientific work of to-day and of the future must be thoroughly grounded in their college training, or its equivalent, and they must bring to their work the best and broadest scholarship and the most thorough special training.

*Commencement Address, Leland Stanford Junior University.

Of certain subjects that the naturalist must study it is not necessary to make mention ; for he who expects to be a botanist will, of course, study the biological branches that are essential to a thorough comprehension of botany. Those things, however, will always take care of themselves. The more difficult questions that arise in the minds of students relate chiefly to studies and other matters that lie without his special line of work.

The general training of a scientific man during the first three years of his college course is not, or should not be, essentially different from that of any man of culture.

In the balancing of the essentials and non-essentials, certain economic considerations have, almost without exception, to be faced at the very outset. Those of us who devote ourselves to pure science are constantly being wearied with that most tiresome of all Philistine questions about the practical value of what a man reads about, thinks about, or does ; how this and that study, this and that bit of training, are going to be of any use—the whole intellectual and cultural bearing of an education being completely ignored. As men who love science for its own sake, we get weary of such questions, and some of us feel driven, in order to emphasize our warnings, to avoid the useful altogether. Thus we occasionally have, on the one hand, men who have a horror of doing anything of practical value ; and on the other, men who have no patience with an investigation which does not promise some material reward. My opinion is that there is little to choose between in these two types. One of them is just as far wrong as the other. Pure science has its place and its work ; so has applied science ; and each in its place is important and indispensable.

Whether one devotes himself to pure or applied science should be decided by one's taste and fitness as far as possible.

Of one thing, however, be assured : without pure science there can be no applied science ; and if anyone hopes to become eminent in either branch he must first lay hold on science itself.

The great advancement, the physical comforts and conveniences—what is generally comprehended under the word progress—of to-day, has not sprung full grown from the brain of applied science, as so many people seem to think. Such progress has been made possible only by the abstruse and apparently aimless and useless generalizations of pure science.

Speaking of men who devote themselves to such work, Mr. Holly says : “ These men do not indeed create the laws of Nature, as they sometimes almost seem to, but they go up into the trembling mountain and the thick darkness and bring down the tables upon which they are written.”

But whatever we study and whatever we do in science, there is to be done in it an immense amount of what engineers know as “ dead work,” that is, work that is quite indispensable, work that doesn’t show to advantage so far as mere display is concerned, but without which the whole superstructure would be liable to go to pieces.

All scientific education and all scientific work is based, or should be based, on a single dogma—the only dogma that science recognizes—and that is, that truth is better than falsehood.

In its professional bearing the most essential part of the training of a man of science should be to the end that he observe well, and that in his deductions he properly subordinate his facts. His preliminary technical training should therefore be for the purpose of teaching him accuracy and detail ; and the necessity of accuracy should be so deeply impressed upon his mind that accuracy will become a part of his nature.

As the whole professional training of the naturalist is for the purpose of enabling him to reach correct conclusions, he should be trained in the use of every method of investigation that will aid him, and among these methods I count as of great importance that of multiple working hypotheses. In my own experience I have found it of the greatest value, and I know of no better way of developing the reasoning powers, or of anticipating difficulties, or of reaching right conclusions, than by the

proper use of hypotheses. I lay some stress upon this point because I find that there are those who think that a man of science can have nothing to do with hypotheses, that he must confine himself to facts. Theory is just as important in science as fact, though performing very different functions.

There are certain things the young naturalist must learn, and it is well for him and for the world if he learn them just as early in his career as possible. To some of these I would call his attention.

In his methods he must always be willing to profit by the experiences of others. Methods and appliances of research are constantly being improved, but the improvements are made, not by disregarding the experience of others, but by making every possible use of it.

The newly fledged sometimes begin with the idea that the world was not discovered until they discovered it, and they think it perfectly safe to discard all human experience. This is one of the signs of a moral disease vulgarly known as the "big-head." When a scientific man gets it he never recovers in time to be of any service to mankind.

I would not have a young man doubt his own ability ; confidence in one's self, if it be well placed, is an important element in success, but it doesn't follow that when one trusts himself he should mistrust all the rest of the world. We hope and believe that the young man of to-day is wiser and better equipped than the young man of any past generation ; but the difference is, after all, not great, and it is quite safe to presume that one's ancestors did know a few things worth knowing.

The necessity of caution on the part of the young man in science in publishing conclusions that one feels to be open to criticism, or when he sees that important facts may have been overlooked, cannot be too strongly emphasized. The publication of facts is generally useful, but deductions can afford to wait until they are properly matured. A most valuable piece of advice once given me was to the effect that young people would better not begin pumping out of their intellectual reser-

voirs before something has been pumped into them. Life is too short, and progress is too slow, for us to cumber the march of science with verbose discussions which help toward strife and contention instead of toward truth and union. "The longer anyone studies a vast subject, the more cautious in inference does he become." To be sure "ignorance is no reason with a fool for holding his tongue"; but my advice is not intended for fools, who will be fools in spite of everybody and everything, but for those who, having sound sense, desire not to bring discredit upon themselves or upon the science to which they are devoted.

Science is not infrequently charged with vacillation. Apropos of this some one remarks: "Science says—but no matter what science says, for the next time she says anything she'll say just the opposite." We cannot deny the justness of the implied criticism; but that it is just must be attributed entirely to premature utterances. We have some sad examples of scientific men whose premature conclusions, drawn from too hasty or incomplete work, have kept half a dozen good men busy for years in correcting their mistakes and in putting the truth before the world. They are usually men of good enough intentions, but "we have a right to expect something more than good intentions of men." All people mean well; it is our business to do well.

Sensationalism is another thing that has done, and will probably continue to do, great injury to all branches of science. There are certain features about every science that impress the uninformed with their novelty, and there are certain persons who are always ready to make capital out of them. This gives rise to a sort of "O my!" class of men and to an "O my!" kind of science. Such people delight in the startling; none of the more radical theories of science, theories put forth by the right thinking with great caution, stagger them. In the scientific man's training, the less we have of the sensational, the better it will be for science and for the man.

Those who are at once workers in science and teachers of

science know how difficult it sometimes is to draw a sharp line between what we know and what we simply believe; but so far as possible this distinction should always be kept before the minds of students, and no effort should be spared to prevent that dazing of their minds which prevents them from weighing evidence and from distinguishing between simple truth, legitimate hypotheses, and simple figments of the imagination.

And now just a word about our responsibilities to our own intellects. Intellect is the tool with which the man of science has to do his work. If that tool is bent out of shape or dulled by improper use, it cannot perform its functions properly. It is highly essential therefore that he keep his intellect unimpaired. He should strive to keep his mind free from those tricks of logic, rhetoric, and sentiment, by which so many of us allow ourselves to be imposed upon. We are bound by every sentiment of honesty to go where our evidence leads us, whether it takes us to a pleasant place or not. Truth must be our companion whether she be an agreeable or a disagreeable one—a handsome or an ugly one. We can not honestly say to reason, “Thus far shalt thou go, but no farther”; we can’t reasonably follow science to certain point and then abandon it for the divining rod or spiritualistic seances or clap-trap appliances of any kind. The man who has no notion of accepting the results of his reasoning would just as well not reason at all; while he who undertakes to reason within certain limits insults his intelligence.

Above all, let me caution young naturalists against what I may call the “debating society” style of reasoning. The debating society is calculated to increase one’s intellectual agility, no doubt, but as its object is the training of advocates, its influence on a man of science is harmful to the last degree, for a scientific man must be a judge—not an advocate.

I take it that it is hardly necessary to speak here of the necessity of one’s interesting himself in a specialty, if he wishes to accomplish much in the way of original work nowadays. In

saying a word for specialties I am fully aware of all that has been urged against this kind of scholarship. The president of one of our greatest educational institutions said to me a few years ago that he had his doubts and fears about the outcome of this modern tendency among scientific men to specialization. Said he: "If this thing goes on, we shall have after a while a man who will know all about the stripes on a trilobite's tail, but he won't know anything else." It is very easy to ridicule a specialist, if the aims of his studies are not comprehended. Galvani studying the twitching of a frog's legs, Darwin breeding pigeons, and Agassiz planting sticks on a glacier, are inspiring or ridiculous in proportion as we comprehend the bearing or end of their studies. Whether studying the twitching of a frog's legs or the stripes on a trilobite's tail is an unworthy and contemptible occupation for an intelligent man depends, therefore, upon the motive and the ultimate objects of the study. And in regard to special work by those who aspire to broad culture in science, I can only say that a man who is incapable of doing and has not done special investigation, is not capable of taking a broad view of science in any of its relations. Mr. Darwin has done some of the best generalizing of our age, but before he did it he had done some of the best of specializing, and that too on such unpractical, uninteresting, and useless animals as the barnacles.

The necessity of specialties has sprung from a necessity of a division of labor in science, just as manual skill comes from a division of labor in the arts. Progress depends on such division.

But while we must confine ourselves to specialties, care should be taken not unnecessarily to diminish the field of our observations. There is a tendency on the part of a certain class of specialists to put everything under the microscope. This is an excellent way of seeing some things; but it is as difficult to examine a landscape with a microscope as it is to examine bacteria without one. Many questions in science can be studied satisfactorily only when we take a broad view of

them, and some discretion must be used in the application of methods.

Inquiries are often addressed to college professors as to what a student should take up as a specialty. This is a matter about which one who is not flippant is slow to give advice. There are some general truths, however, that are applicable to all cases :

First. You should not mistake your ambition for your natural calling. It doesn't follow, because you would like to be a Darwin, that you are cut out for one.

Second. You must not imagine because you love nature that you were born for a naturalist. This kind of a mistake is often made by young people.

It is not to be supposed that the man who studies plants is necessarily in love with plants, or that the entomologist is necessarily in love with insects.

The lover of nature is a poet whose fancy endows nature's bare facts with attributes that the naturalist, as such, knows nothing about. One sometimes hears it said that Wordsworth and Lowell would have made good naturalists. I doubt it ; what they say of birds and trees and flowers and sunshine and snow are certainly no evidence of it.

The methods of the man of science deal not with the beauties of nature as beauties, but with the facts and laws. Do you suppose that our great ichthyologist is in love with fishes? Not at all ; his interest in fishes is an interest in natural law. The naturalist is a classifier ; and one must be guided in choosing natural history as a profession by the taste and fitness for classification and for nature's problems, rather than by one's admiration for the beauties of the flowers or the songs of the birds.

Besides, to be a successful man of science one must go into science very largely, because he can't help it—because he can't keep out of it. I mean, of course, that the particular branch of science he enters must so fill the demands of his mind, his temperament, and his tastes, that in any other occupation he

feels that he is not where he can make the most of himself and of his energies. Such men will have that professional pride, zeal, and ambition, without which everyone is doomed to a fatal mediocrity. This point was well illustrated in the experience of one of the prominent geologists of this country. The story of how he found his real calling was thus told me a short time ago by his father. Said he: "Edward studied civil engineering and did more or less work at it, and we had settled it in our minds that he was to be an engineer. But I noticed that although he did good work and rather enjoyed it, he didn't go out with the engineers every time he had a chance, and if he happened to want to go with them, it didn't take much to divert his attention from their work; he never offered to carry stakes or a chain just for the sake of being where engineering was going on. Then he took a fancy for mechanics, and studied that diligently for two or three years, and worked in the shops until he became pretty skillful, and then we settled it in our minds that Edward was going to be a mechanical engineer. But," said the father, "after all, I had my doubts about it; I noticed that while he was a good mechanic we never had to drag him away from his work; he was always on time at his meals and he went to and came from his work as if it were all a mere matter of duty."

"Finally, he took to geology, and then he lost his whole heart. Days were too short and nights too long; holidays he no longer knew; eating and sleeping became disagreeable necessities; social duties and everything else than his beloved science were put off till a more convenient season." It is hardly necessary for me to tell you that that young man made a geologist of whom we are all proud.

And this case is no exception, indeed it is quite a typical one. There is thus going on a process of natural selection that puts every man in his place—that is where he can best serve the world; and such a process makes it the more necessary that young people should make no mistakes in the choice of a calling or in the preparation for it.

And now I want to say a word about a part of the naturalist's education that is not comprehended in his directly preparatory studies ; at least, not as preparatory studies now go in this country, or in the ethical relations of his professional work.

Though I believe in specialties, I am not disposed to side with those who think that if a man is to be a specialist the sooner he begins his specialty the better. In a general way this proposition is correct, but in making such an admission it must be distinctly understood that all things which tend to broaden a man's scholarship form essential parts of his specialty. For while I believe most heartily in specialization I believe none the less heartily in a general education for the man of science. There has been a disposition of late to rush to the other extreme, largely because the old-fashioned classical education has, on the whole, been so unsatisfactory.

One should certainly have more than a single window in the intellectual house in which he must pass his life.

Specialize, yes, by all means specialize, but apart from your specialty see that your intelligence is properly cultivated on as many sides as possible. Grow up—not like a telegraph pole, useful, but bare and ugly—but like a well proportioned tree with branches on all sides to gather into your life the fresh air and the sunshine.

John C. Branner

ROMAN EDUCATION * †

Illa laus est magno in genere et divitiis maximis liberos hominem educare generi monumentum et sibi. Plant.

CHAP. I

THE ROMAN PEOPLE

In passing from the Hellenic Races to the Roman people, we enter a new phase of life and yet one which, while different,

*Authorities :—Chiefly based on *Loci Classici*; also Suetonius, de Gramm.; Becker's Gallus; *Erziehung und Jugendunterricht bei den Griechen u. Römern*, von, J. L. Ussing;